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(71) Applicant(s)
Malcolm Leonard Stephen Dean

(54) Inventor(s)
Samuel Arthur Thomas Woodbridge

[redacted] [redacted]

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Form 1

APPLICATION FOR A PATENT

I ~~WE~~ SAMUEL ARTHUR THOMAS WOODBRIDGE
(Use BLOCK letters)

of 85 BUNYA STREET
GREENSLOPES 4120

hereby apply for the grant of a Patent for an invention entitled SPIN CONTROL DIFFERENTIAL, CONTROLLED BY AN OVER-DRIVE COUPLING AND A CLUTCH.

which is described in the accompanying provisional ~~complete~~ specification.

My ~~Our~~ address for service is 85 BUNYA STREET
GREENSLOPES 4120

Dated this TWELTH day of NOVEMBER 1987

To:
THE COMMISSIONER OF PATENTS

Arthur Woodbridge
(*Signature*)

This form must be accompanied by either a provisional specification (Form 9 and true copy) or by a complete specification (Form 10 and true copy).

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DECLARATION IN SUPPORT OF AN APPLICATION FOR A PATENT

In support of the Application made by me for a Patent for an invention entitled "SPIN-CONTROL DIFFERENTIAL",

I, SAMUEL ARTHUR THOMAS WOODBRIDGE, of 85 Bunya Street, Greenslopes, Queensland, 4120, Australia, do solemnly and sincerly declare as follows:

1. I am the Applicant for the Patent.

2. I am the actual inventor of the invention.

DECLARED at Brisbane, Queensland, this fifteenth day of November 1988.

Samuel Arthur Thomas Woodbridge

Samuel Arthur Thomas WOODBRIDGE

GRANT ADAMS & COMPANY,
333 Adelaide Street,
BRISBANE. QLD. 4000
AUSTRALIA.

TO:

The Commissioner of Patents
COMMONWEALTH OF AUSTRALIA

(12) PATENT ABRIDGMENT (11) Document No. AU-B-25125/88
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(54) Title
SPIN CONTROL DIFFERENTIAL

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(71) Applicant(s)
SAMUEL ARTHUR THOMAS WOODBRIDGE

(72) Inventor(s)
SAMUEL ARTHUR THOMAS WOODBRIDGE

(74) Attorney or Agent
GRANT ADAMS & COMPANY, GPO Box 1413, BRISBANE QLD 4001

(56) Prior Art Documents
AU 572273 39873/85 F16H
AU 570800 42509/85 F16D
AU 558208 32446/84 F16H

(57) Claim

1. A spin-control differential for vehicles including:

a differential housing;

a crown wheel in the housing;

a pair of axles, connectable to driving hubs, operably interconnected by side gears and pinion gears within a cage in the crown wheel;

a pair of overdrive (or underdrive) couplings, each operably connected to a respective one of the axles or the crown wheel;

a pair of clutches, each operably connected to the crown wheel or a respective one of the axles; and

a respective tubular body interconnecting each coupling and clutch pair;

so arranged that when one of the axles rotates at a rotational speed a preset ~~predetermined~~ percentage less than the rotational speed of the crown wheel, the respective clutch for the one axle will engage to

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prevent the rotational speed of the axle from falling below the preset percentage and will disengage when the rotational speed of the axle exceeds the preset ~~present~~ percentage.

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Name of Applicant	:	SAMUEL ARTHUR THOMAS WOODBRIDGE
Address of Applicant	:	85 Bunya Street, Greenslopes, Queensland, 4120, Australia
Actual Inventor	:	SAMUEL ARTHUR THOMAS WOODBRIDGE
Address for Service	:	GRANT ADAMS & COMPANY, Patent & Trade Mark Attorneys, 333 Adelaide Street, BRISBANE. QUEENSLAND. 4000 AUSTRALIA.

COMPLETE SPECIFICATION FOR THE INVENTION ENTITLED:

"SPIN-CONTROL DIFFERENTIAL"

The following statement is a full description of the invention including the best method of performing it known to the applicant.

THIS INVENTION relates to a spin-control differential for vehicles.

In Australian Patent Nos. 545433; 558208 and 570800, I have disclosed different types of spin-control differentials. In each, a full differential action is provided while limiting the rotational speed of the axles to not exceed, or fall below, predetermined percentages of the crown wheel speed.

It is an object of the present invention to provide an improved form of such a spin-control differential.

It is a preferred object to provide such a differential where the axles do not fall below a predetermined percentage of the crown wheel speed.

Other preferred objects of the present invention will become apparent from the following description.

In a broad aspect the present invention resides in a spin-control differential for vehicles including:-

a differential housing;

a crown wheel in the housing;

a pair of axles, connectable to driving hubs, operably interconnected by side gears and pinion gears within a cage in the crown wheel;

a pair of overdrive (or underdrive) couplings, each operably connected to a respective one of the axles or the crown wheel;

a pair of clutches, each operably connected to the crown wheel or a respective one of the axles; and

a respective tubular body interconnecting each coupling and clutch pair;

so arranged that when one of the axles rotates at a rotational speed a preset ~~predetermined~~ percentage less than the rotational speed of the crown wheel, the

respective clutch for the one axle will engage to prevent the rotational speed of the axle from falling below the preset percentage and will disengage when the rotational speed of the axle exceeds the ~~present~~ preset percentage.

As the axles are interconnected by the side and pinion gears, the other axle cannot exceed a preset percentage of the crown wheel rotational speed.

Preferably in the straight ahead direction, both clutches are disengaged and the respective couplings overdrive the tubular bodies relative to the crown wheel speed.

Preferably each clutch is a ramp-and-roller type clutch and preferably the clutch has a central star gear operably mounted on a tubular extension on the crown wheel (or the cage) which surrounds the inner end of the respective axle. Preferably the rollers releasably engage the star gear and the tubular body and are spaced apart by a finger plate.

Preferably each overdrive (or underdrive) coupling has a stationary cam surrounded by the tubular body which has a plurality of scallops in its inner wall. A plurality of rollers, pegs or "peanuts", spaced by fingers on the axle, are interposed between the stationary cam and the tubular body and the number of rollers, pegs or "peanuts" is greater than the number of scallops in the overdrive (or underdrive coupling).

The coupling can have a double row cam and two rows of rollers, pegs or "peanuts".

Preferably the clutches are positioned adjacent the crown wheel to engage before the respective couplings but this may be reversed if preferred.

To enable the invention to be fully understood, a number of preferred embodiments will now be described with reference to the accompanying

drawings, in which:

FIG. 1 is a sectional side view of a first embodiment of the differential;

FIG. 2 is a sectional end view, taken on line 2-2 on FIG. 1, of an overdrive coupling;

FIG. 3 is a sectional end view, taken on line 3-3 of a ramp-and-roller clutch;

FIG. 4 is a sectional end view of a second embodiment of the differential;

FIG. 5 is a sectional end view, taken on line 5-5 on FIG. 4, of the ramp-and-roller clutch; and

FIG. 6 is a sectional side view of a portion of a third embodiment of the differential where the overdrive coupling is a two-row coupling and is adjacent the crown wheel.

Referring to the first embodiment of FIGS. 1 to 3, the differential 10 has a housing 11 and axle tubes 12. The crown wheel 13 is driven by a pinion (not shown) on the input shaft (also not shown) and is bolted to a cage 14 fitted with side gears 15 and pinion gears 16. The cage 14 has tubular extensions 17 supported by suitable bearing assemblies 18.

Each axle 19 is connected to a driving hub (not shown) at the outer end of the axle, the axle being supported by suitable bearings (not shown) in its axle tube 12.

The inner end 20 of each axle 19 is splined and received in a splined socket 21 at the outer end of a respective inner axle 22 operably connected to a respective side gear 15.

A bi-directional overdrive coupling 23 (see FIG. 2) has a stationary cam 24 fixed to the housing 11, surrounding an axle 19.

A tubular body 25 surrounds, and is spaced from, the stationary cam 24 and, as shown in FIG. 2, has

(e.g. 14) scallops 26 in its inner face at its outer end. A plurality (e.g. 16) peanuts 27 are interposed between the stationary cam 24 and the tubular body 25 and are spaced by fingers 28 on the outer end of the inner axle 22.

When the inner axle rotates one turn, it causes the tubular body to rotate (16/14) turns i.e. approximately 14% faster. Therefore, the inner axle 22 overdrives the tubular body 25 by 14%.

The inner end of the tubular body 25 is plain cylindrical and forms part of the ramp-and-roller clutch 29, see FIG. 3.

The ramp-and-roller clutch 29 has a central star gear 30 (hexagonal in end view) fixed to the outer end of the tubular extension 17 of the cage 14. A plurality of rollers 31 are interposed between the star gear 30 and the tubular body 25 and are spaced by fingers 32 on a finger plate 33. The finger plate 33 is urged into frictional contact with a stationary plate 34, fixed in the housing 11 by springs 35 received in bores in the star gear 30.

When the tubular body 25 is rotating at a higher speed than the star gear 30, the rollers are moved to a position e.g. as shown in dashed lines in FIG. 3, where the tubular body and the star gear are disengaged, the rollers overcoming the inertial drag of the inertia plate 33. (The fingers 32 prevent the rollers moving forward to a position where they lock up the tubular body and star gear.) When the rotational speed of the tubular body equals that of the star gear, the inertial drag of the finger plate causes the fingers 32 to retard the rollers 31 into driving engagement between the tubular body and star gear as shown in FIG. 3.

The operation of the differential will now be

described.

In the straight ahead position, both axles 19 will rotate at 100% crown wheel speed. Each axle 19, via its inner axle 22, will overdrive its tubular body 25 at 114% crown wheel speed via its overdrive coupling 23. As each tubular body 25 is rotating faster than the respective star gear 30 (which is rotated at 100% crown wheel speed by its tubular extension 17), the clutches 29 will be disengaged.

When the vehicle turns a corner, and the axles 19 rotate within e.g. 10% of crown wheel speed, normal differential action between the axles 19, via the side and pinion gears 15, 16 will occur.

When, however, the rotational speed of one of the axles 19 falls to 86% of the crown wheel speed (i.e. 14% below the crown wheel speed), the tubular body 25 for that axle will be driven at 100% crown wheel speed (i.e. 114% of the axle speed). The drag on the finger plate 33 will cause the fingers 32 to retard the rollers 31 and engage the clutch 29 for that axle 19, which can now not rotate at less than 86% of crown wheel speed.

The other axle 19, if it loses traction, rotates at approximately 114% crown wheel speed through the differential action and its tubular body, rotating at approximately 130% crown wheel speed (i.e. 114% of 114%) ensures that its clutch 29 free wheels.

As the vehicle comes out of the turn, the slower axle 19 speeds up and the clutch 29 is released.

It will be noted that the spin-control is applied to the slower axle, not the faster axle as in most spin-control differentials.

Referring now to the second embodiment of the differential shown in FIGS. 4 and 5, the arrangement of the differential 100 is generally as for the differential 10 of FIG. 1 and the same overdrive

couplings are used. The ramp-and-roller clutches 101 are slightly different, however.

Each clutch 101 (see FIG. 5), has a tubular body 102, star gear 103, rollers 104 and fingers 105 on an finger plate 106, the latter in frictional engagement with a stationary plate 107. An inner finger ring 108 is interposed between the finger plate 106 and the star gear 103 and has pegs 109 engaged in buttons 110 slidably received in slots 111 in the side face of the star gear.

Peg 112 on the finger plate 106 enters the slots 111. As shown at A in FIG. 5, when the inertia plate 108 lags back relative to the star gear 103, the pegs 112 on the inertia plate have only limited movement in the slots 111 and so the inertia plate cannot overrun the star gear to allow the rollers 104 to move to the wrong end of the ramp or the star gear. (The position of the rollers 104 when the clutch is overrunning (i.e. disengaged) is shown in dashed lines in FIG. 5.)

Referring now to the third embodiment of FIG. 6, the differential 200 has the ramp-and-roller clutches 201 (e.g. of the type of clutches 29 of FIG. 3) connected to the inner axles 202 (which is connected to the axles 203) and the overdrive couplings 204 connected to the tubular extensions 205 of the cage (not shown).

The stationary cam 206 has two rows of cam faces 207, preferably offset by 70-90°, while the tubular body 208 has a single row of scallops 209.

Two rows of peanuts 210 engage the stationary cam 206 and the tubular body 208, being spaced by fingers 211 on an annular extension 212 of the tubular extension 205.

By this arrangement, with 14 scallops on the tubular body 208 and 16 peanuts 210 in each row, the tubular body 208 is overdriven at 114% crown wheel speed

but twice the number of peanuts are in driving engagement at any one time compared with the coupling 23 in FIG. 2.

The degree of overdrive of the tubular bodies relative to the axles or the crown wheel can be varied by changing the ratio of scallops and peanuts but 114% overdrive is preferred, as this sets the lowest axle speed limit at 86% of crown wheel speed. Preferably the lower limit will be in the range of 80-90% crown wheel speed.

It will be readily apparent to the skilled addressee that various changes and modifications may be made to the embodiments described and illustrated without departing from the scope of the present invention defined in the appended claims.

CLAIMS

The claims defining the invention are as follows:

1. A spin-control differential for vehicles including:

a differential housing;

a crown wheel in the housing;

a pair of axles, connectable to driving hubs, operably interconnected by side gears and pinion gears within a cage in the crown wheel;

a pair of overdrive (or underdrive) couplings, each operably connected to a respective one of the axles or the crown wheel;

a pair of clutches, each operably connected to the crown wheel or a respective one of the axles; and

a respective tubular body interconnecting each coupling and clutch pair;

so arranged that when one of the axles rotates at a rotational speed a preset ~~predetermined~~ percentage less than the rotational speed of the crown wheel, the respective clutch for the one axle will engage to prevent the rotational speed of the axle from falling below the preset percentage and will disengage when the rotational speed of the axle exceeds the preset ~~present~~ percentage.

2. A differential as claimed in Claim 1 wherein:

in the straight ahead position, the couplings overdrive their respective tubular bodies relative to the crown wheel speed and the respective clutches are disengaged.

3. A differential as claimed in Claim 1 or Claim 2 wherein:

each clutch is a ramp-and-roller type clutch with a central star gear operably connected to a tubular extension on the crown wheel or the cage, and rollers releasably engage the star gear and tubular body when they are rotating at the same speed.

4. A differential as claimed in Claim 3 wherein:

the rollers are spaced apart by fingers on a finger plate which rotates with the star gear but which is in frictional contact with a stationary plate in the housing, the finger plate being operable to move the rollers to the engaged position when the rotational speed of the tubular body decreases to the rotational speed of the star gear.

5. A differential as claimed in any one of Claims 1 to 4 wherein:

each coupling is a bi-directional overdrive coupling having a stationary cam mounted in the housing;

the tubular body surrounds the stationary cam and in spaced therefore;

a plurality of scallops being provided in the inner wall of the tubular body;

a plurality of rollers, pegs or peanuts are interposed between the stationary cam and the tubular body, the number of rollers, pegs or peanuts being greater than the number of scallops; and

the rollers, pegs or peanuts are spaced by fingers on the axle or on extensions thereof.

6. A differential as claimed in Claim 5 wherein:

the stationary cam has two rows of cam faces engaged by respective rows of rollers, pegs or peanuts, the number or rollers, pegs or peanuts in each row being equal and greater than the number of scallops in the tubular body.

7. A differential as claimed in any one of Claims 1 to 6 wherein:

each axle rotates its respective tubular body at (100 + x)% of the crown wheel speed through its respective overdrive coupling and the respective clutch will be disengaged in the straight ahead position, but the axle will be limited to rotation at (100 - x)% of

crown wheel speed when the vehicle turns a corner, the tubular body being driven at 100% crown wheel speed to ~~cuse~~ cause the clutch to engage.

8. A differential as claimed in Claim 7 wherein: the slower of the two axles is limited to rotating at 80-90% crown wheel speed, where x = 10-20%.

9. A differential as claimed in Claim 8 wherein: the slower of the two axles is limited to rotating at 86% crown wheel speed, where x = 14%.

10. A spin-control differential for vehicles substantially as hereinbefore described with reference to FIGS. 1 to 3; FIGS. 2, 4 and 5; or FIGS. 1 to 3 as modified by FIG. 6; or FIGS. 2, 4 and 5 as modified by FIG. 6.

DATED this sixteenth day of November 1988.

SAMUEL ARTHUR THOMAS WOODBRIDGE,
by his Patent Attorneys,
GRANT ADAMS & COMPANY.

DRAWINGS

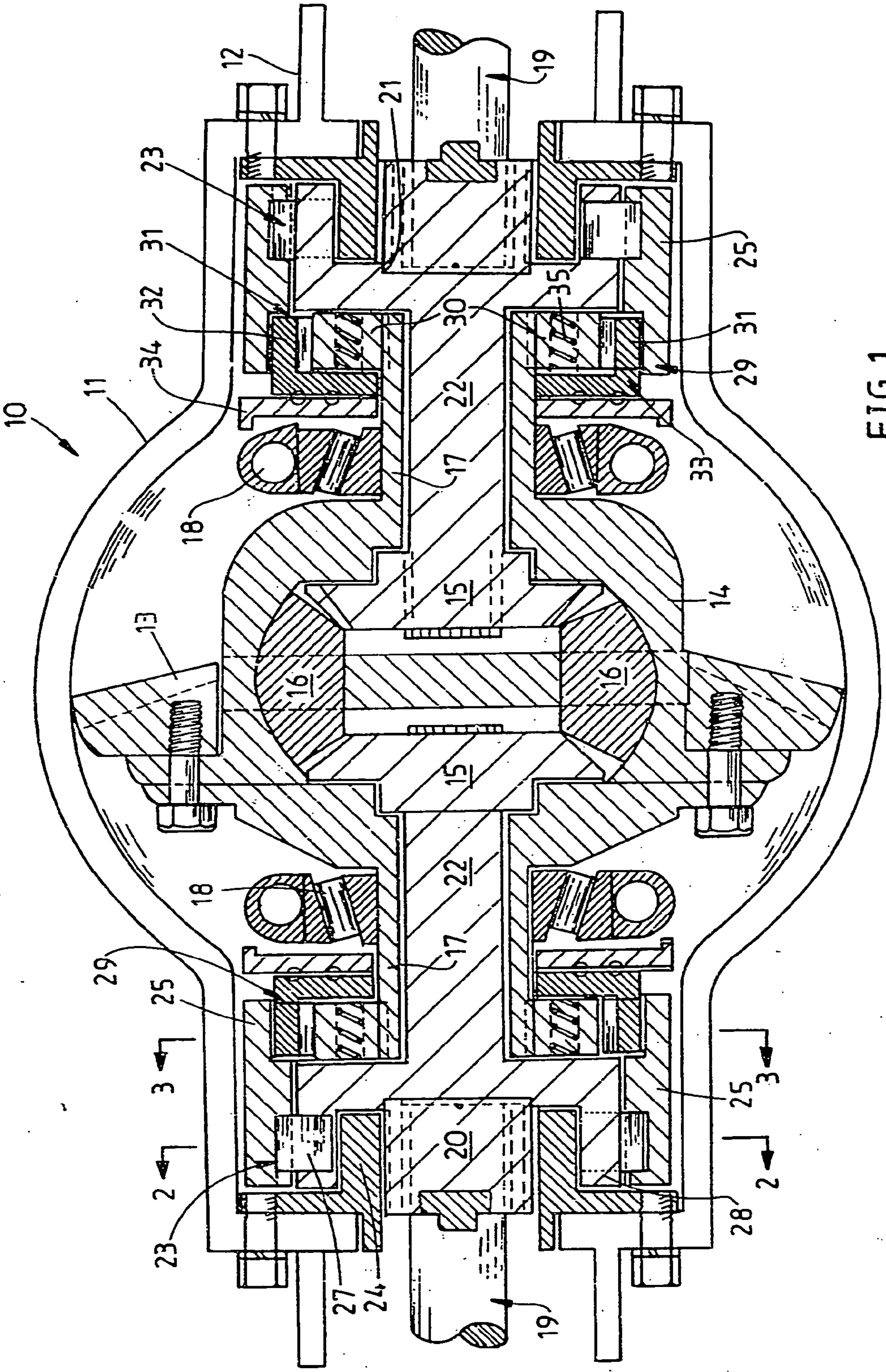
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FIG.1

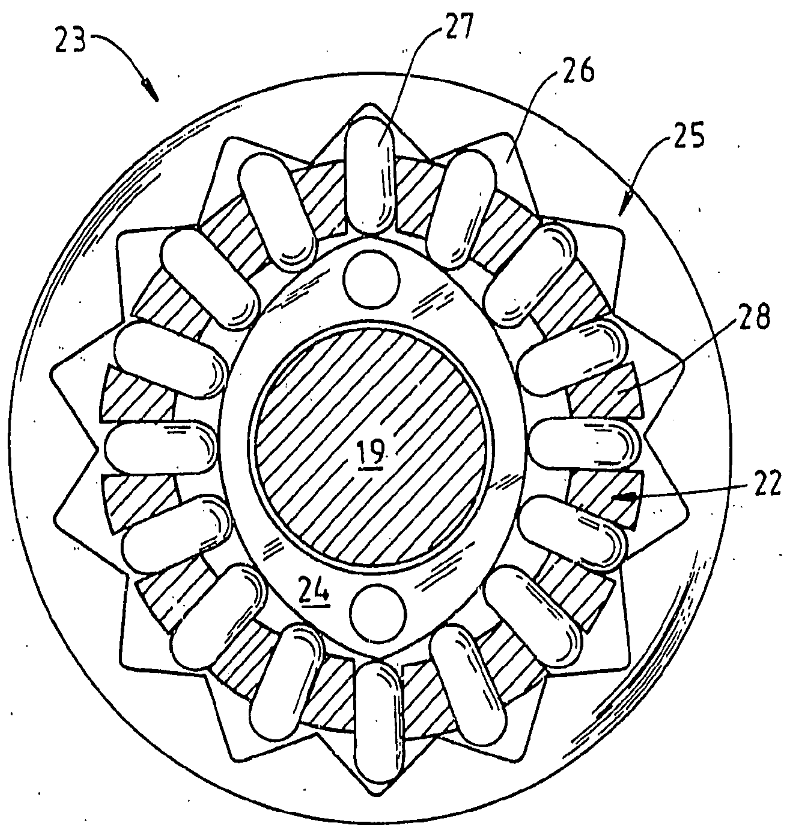

FIG. 2

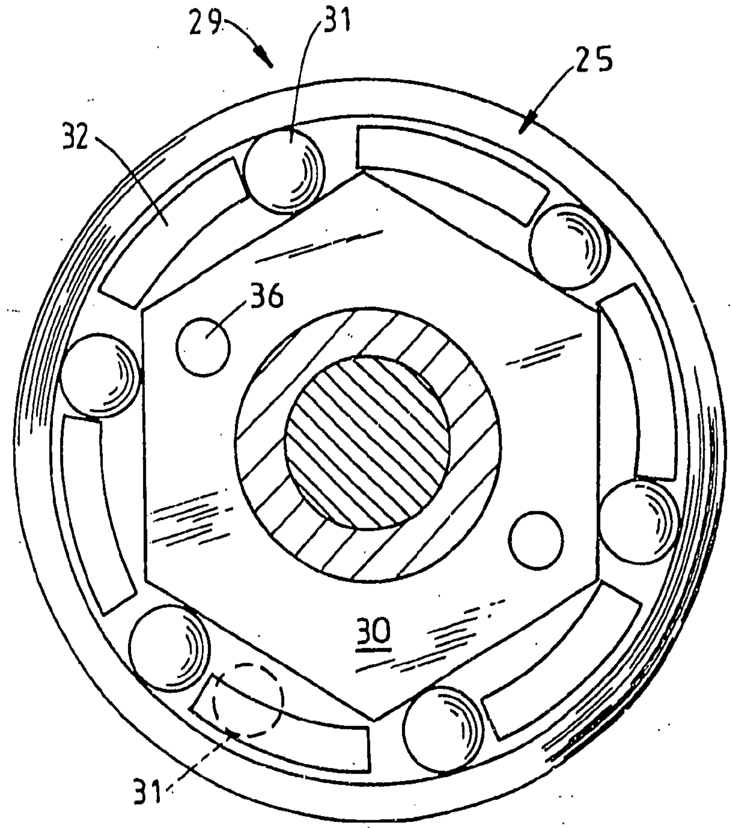

FIG. 3

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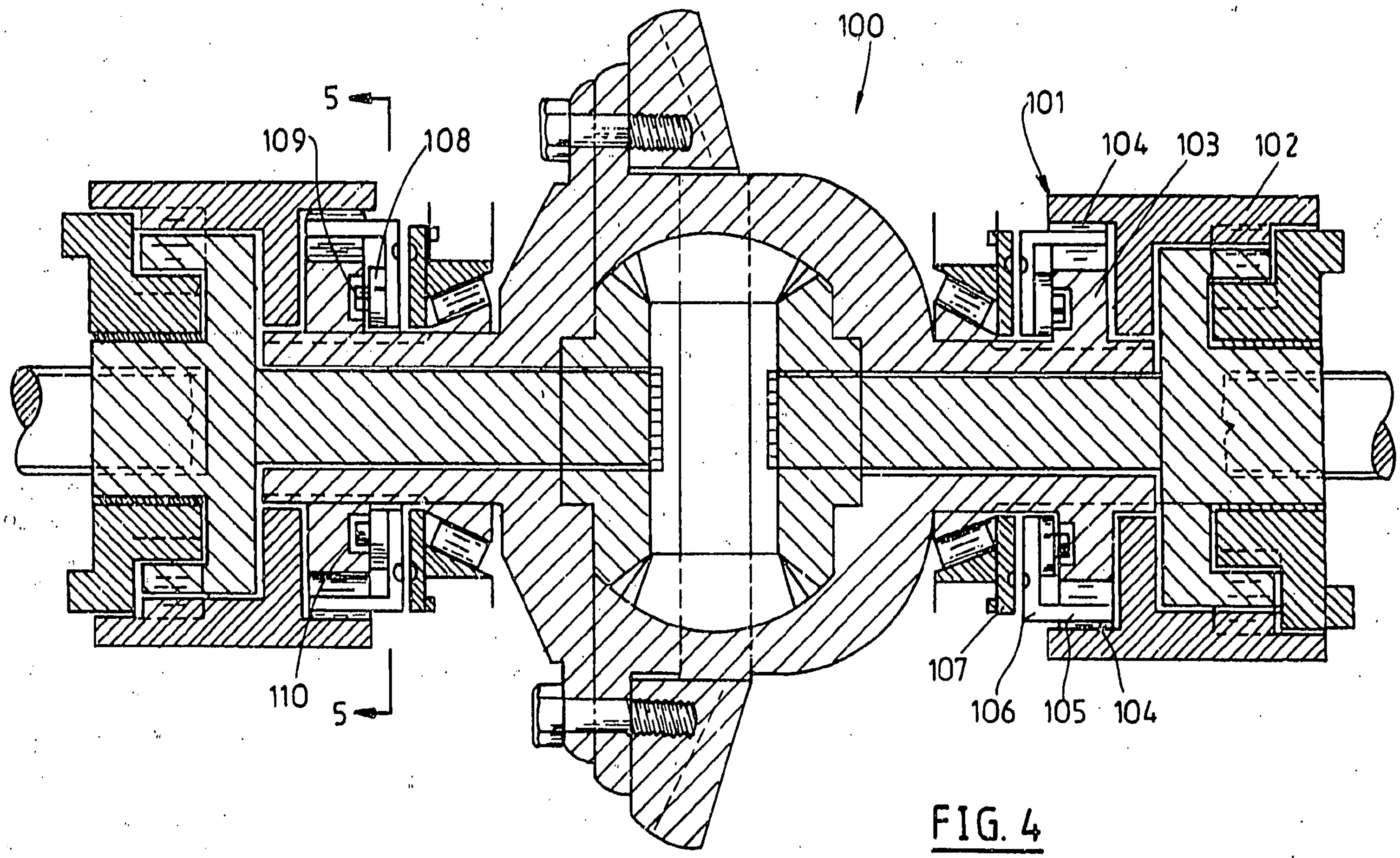

FIG. 4

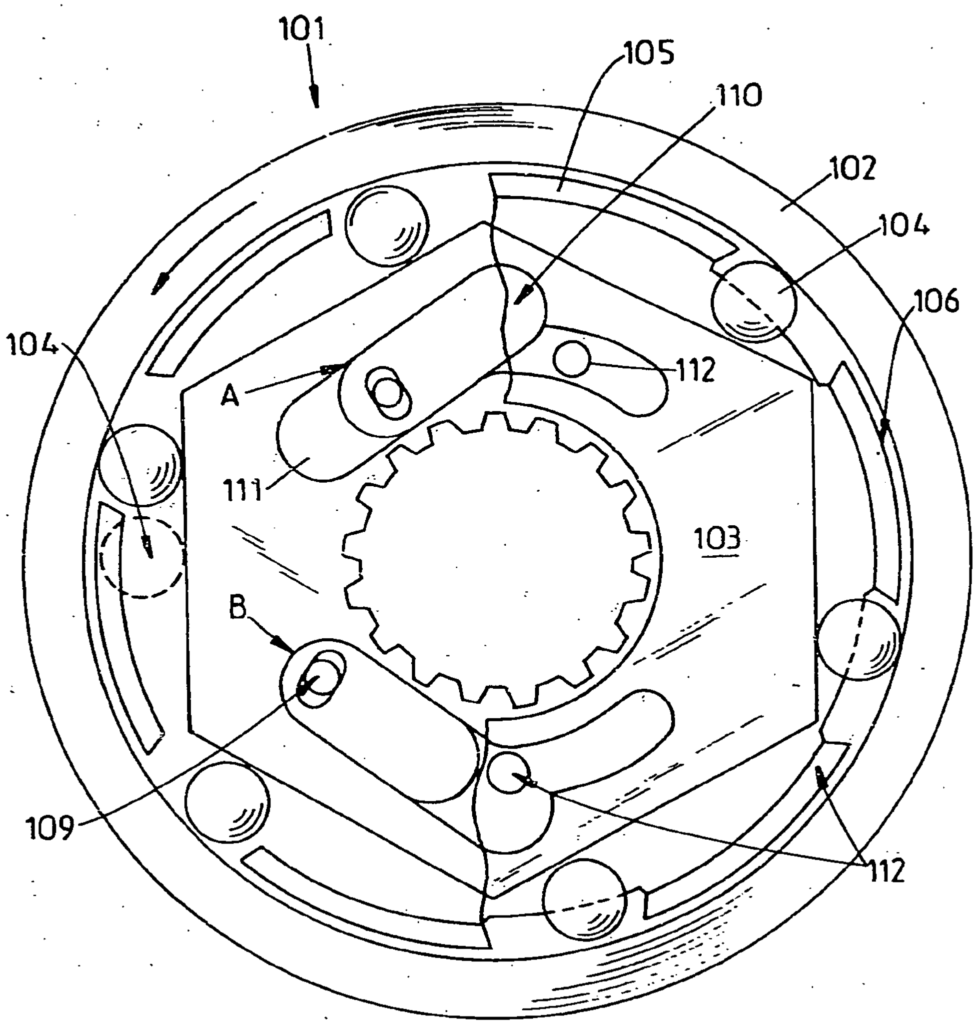

FIG. 5

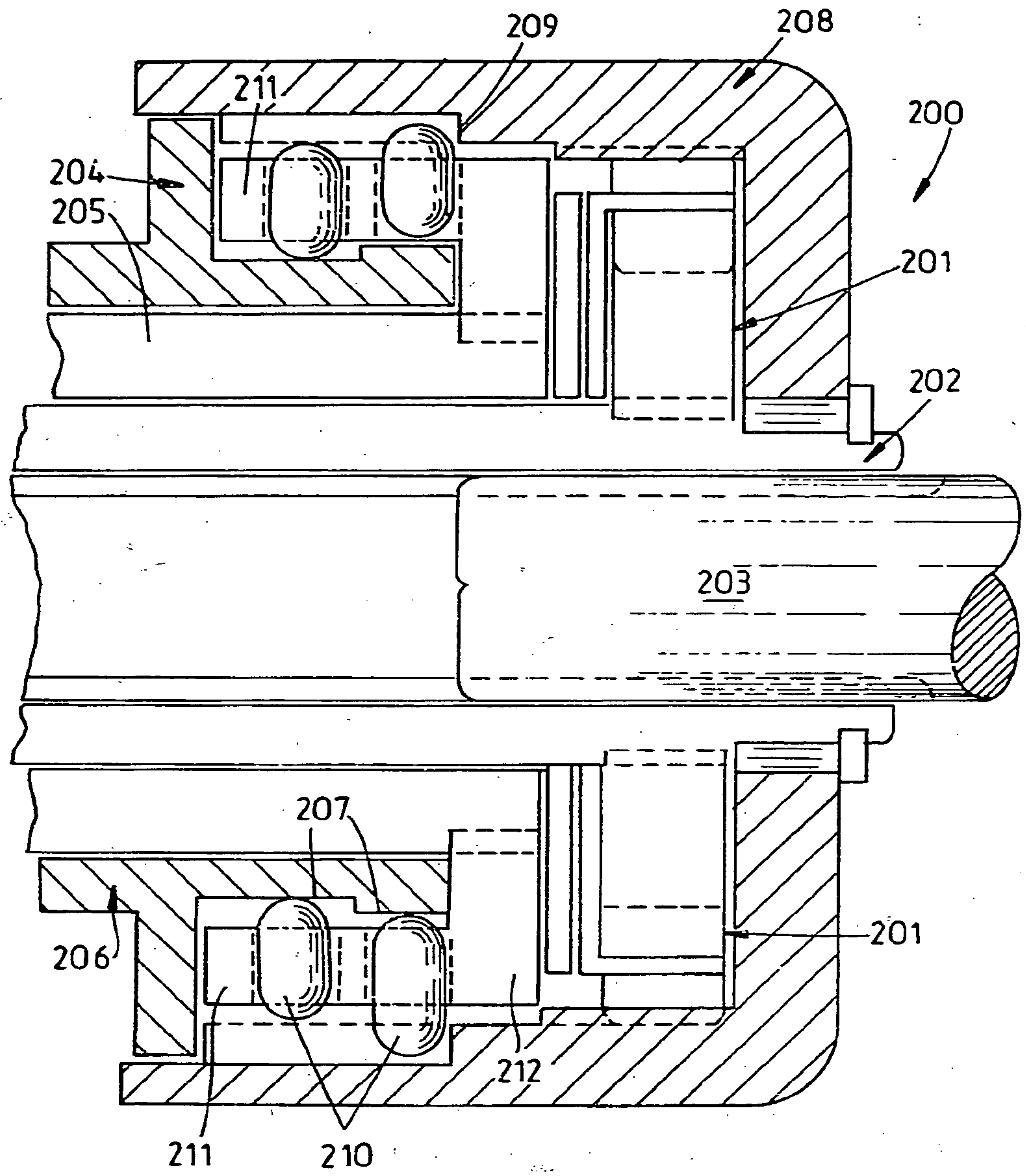

FIG. 6